NISTTech

Photoacoustic Spectrometer With Calculable Cell Constant for Quantitiative Absorption Measurements of Pure Gases, Gaseous Mixtures, and Aerosols

Measurements of Pure Gases, Gaseous Mixtures, and Aerosols

Description

This invention is a spectrometer for measuring constituents in gas samples based on a photo-acoustic (PA) principle that combines first-principle models of acoustic wave propagation with high-resolution spectroscopic measurements. The sample gas to be measured flows through a PA resonator where the gas is exposed to periodically-switched light from a laser source. Absorbing species in the gas or particulate matter are heated and thermally expand, creating an acoustic wave that is detected by a microphone placed in the resonator. The microphone mount assembly and its placement in the resonator are designed to detect the primary acoustic mode.

Applications

- • The PA spectrometer could serve as a high-accuracy and low-cost greenhouse gas sensor for deployment in distributed networks
- • Useful for measuring isotope ratios in atmospheric particulates
- • Possible use as a standard CO2 reference spectrometer

Advantages

- • The simplicity of the PA spectrometer reduces cost by eliminating the need to calibrate against costly reference gas standards
- • The system enables dynamic compensation for fluctuations in temperature, pressure, relative humidity, and sample composition

Abstract

We have invented and modeled an intensity-modulated, laser-driven photoacoustic (PA) spectrometer with a calculable cell constant. The uncertainty in the calculated cell constant has been demonstrated to be about 1% or less. To this end, we combined first-principles models of acoustic wave propagation with high-resolution spectroscopic measurements. We modeled and measured the absolute response of an intensity-modulated photoacoustic spectrometer comprising a 10 cm long resonator and having a Q-factor of approximately 30. We used a detailed theoretical analysis of the system and predicted its response as a function of gas properties, resonance frequency, and sample energy transfer relaxation rates.

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Citations

1. K.A Gillis, D.K. Havey, and J.T. Hodges, Standard Photo acoustic Spectrometer: Measurements of Greenhouse Gases and Aerosol Particles, Review of Scientific Instruments. **81**, 064902, 2010.

References

- Serial #12/985981 dtd 1/6/2011
- Docket: 10-018

Status of Availability

This invention is available for licensing exclusively or non-exclusively in any field of use.

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